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Structural Separation and Prospects for Welfare-Enhancing Price Discrimination in a New ‘Natural Monopoly’ Network: comparing fibre broadband proposals in Australia and New Zealand

Dave Heatley and Bronwyn Howell*

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*Dave Heatley is a Research Fellow and Bronwyn Howell is General Manager at the New Zealand Institute for the Study of Competition and Regulation. The views in this paper represent those of the authors and do not necessarily represent those of the institutions with which they are affiliated.

Postscript: in early July 2010 the New Zealand Minister for Communications Steven Joyce announced fundamental changes to the structure and regulation of the New Zealand Government’s Ultra-Fast Broadband Initiative. The changes were deemed necessary in order to achieve uptake targets sufficient to underpin the business case for both government and private sector investment. For a discussion of those changes and how they interact with the issues raise in this paper please refer to: Heatley, D. & Howell, B. (2010). “UFBI 2.0: Revised separation boundaries may partially address pricing and uptake limitations in New Zealand fibre broadband model, but significant competition policy problems remain”. *Current Comment*. 2010 No. 2. ISCR. Available from: <http://www.iscr.org.nz/n594.html>.

Abstract

The Australian and New Zealand governments have both decided that substantial government investment is required to accelerate the deployment of new nationwide fibre-to-the-home (FTTH) networks. This paper examines the two proposals in light of the crucial role of price discrimination in enabling rapid and early uptake of a new technology with a natural monopoly cost structure, given the assumptions that both networks will be subject to provisions that separate elements of network ownership from retail operations, and both will face competition from other (vertically integrated) network technologies.

Whilst price discrimination enables a monopolist to maximise profits by extracting surplus from consumers, when the firm has a natural monopoly cost structure it also enables the firm to increase welfare by accessing scale economies (static efficiency gains) and to introduce the technology earlier than under the counterfactual of a single price (dynamic efficiency gains). However, vertical separation of network and retail functions and regulated ‘open access’ and ‘equivalence’ requirements, used as regulatory tools to increase retail competition and constrain price and non-price discrimination by monopoly network operators, restricts the ability of a new network operator to use its price structure to introduce the technology in a timely manner and to gain access to welfare-enhancing scale economies. In a competitive environment, when the new (frontier) network must build its customer base principally from the substitution of customers from the existing (legacy) natural monopoly networks (which may be vertically integrated and engaging in price discrimination themselves), the non-discriminatory provisions of structural separation impose substantial limitations upon the regulated firm’s business case.

Both the Australian and New Zealand FTTH proposals impose separation and non-discrimination requirements as a precondition for government financing, although they differ in their approaches in respect of both the point at which the separation must be enforced and the extent of competition anticipated from existing network operators. Whilst neither proposal enables the full efficiency gains available from producing at maximum efficient scale to be realised, the Australian proposal, with integration of Layer 1 and 2 operators and acquisition of the competing copper access network appears to offer efficiency and substitution advantages over the New Zealand proposal, which requires separation between layer 1 and 2 operators and provides no clear view of the competitive positioning of the FTTH network relative to the legacy copper access rival.

Introduction

Over the past five years, near-universal availability of fibre-to-the-home (FTTH) internet access has become a reality in countries such as Japan, Singapore and Korea. Substantial deployment of fibre-based networks has also been occurring in countries such as the United States, the Netherlands, Finland and Denmark. Fuelled by concerns about maintaining future international competitiveness (in particular in relation to increasingly important Asian markets where fibre is already widely deployed) both the Australian and New Zealand governments have pledged to invest substantial sums into the construction of nationwide fast FTTH broadband networks¹. In both countries it is envisaged that connections delivering 100Mbps both downloading from and uploading to the internet will be available to the vast majority of households within ten years².

The Australian National Broadband Network (NBN)³ and the New Zealand Ultra-Fast Broadband Initiative (UFB)⁴ proposals share many common features. Both presume that a single FTTH network with a geographic monopoly⁵ will be built, and that public financing at an early stage (i.e. in advance of voluntary commitment of private sector investment) will accelerate its deployment and the accrual of the presumed attendant benefits⁶. As the creation of a single infrastructure invokes concerns about potential negative consequences from the exertion of market power, and in order to encourage competition and innovation in those non-monopoly parts of the industry where it is deemed achievable, both proposals mandate vertical separation between the (upstream) infrastructure owner(s) and (downstream) retailers of services provided using that infrastructure, and an “open access”⁷, “non-discriminatory” pricing regime whereby downstream retailers are charged identical prices for identical services by the upstream infrastructure owner(s)⁸.

However the proposals differ in some important respects on where the boundaries of the structurally separate firms will be drawn, and competitive positioning of the fibre firms relative to

¹ Grimes, Ren & Stevens (2009).

² The Australian target is coverage of 90-93% of the population, whereas the New Zealand target is 75%.

³ http://www.dbcde.gov.au/broadband/national_broadband_network

⁴ http://www.med.govt.nz/templates/ContentTopicSummary_41902.aspx

⁵ Thereby avoiding potential duplication of investment resulting when two or more firms building fast broadband access networks.

⁶ See Howell & Grimes (2010) for a discussion of the policy assessment process of the likely benefits from fast fibre networks.

⁷ Whereby the network operator is required to sell elements of access to the network to any access seeker at regulated rates (Hausman & Sidak, 2005).

⁸ In order to prevent the foreclosure of downstream competitors by the network operator making access available to its own downstream firm under more attractive terms than those offered to competitors (Xavier & Ypsilanti, 2004).

the incumbent copper network providers. Based upon the ISO reference model⁹, generic structural separation proposals identify three ‘layers’ within the supply and distribution of FTTH (and other data communications) networks: Layer 1, or the ‘physical layer’, which provides the dark fibre connection between the household and a local aggregation node (akin to copper connections under local loop unbundling); Layer 2, or the ‘data link layer’, whereby dark fibre links are converted into bitstream connections over which internet traffic can be passed (akin to wholesale services offered by incumbent telecommunications companies, and by unbundling entrants using their own equipment in incumbents’ facilities); and Layer 3 or ‘network layer’ services whereby retailers (for example, internet service providers or ISPs) offer cross-network communication and data access plans to consumers.

The Australian proposal presumes that the government-owned and operated firm (NBNC_o) will provide all Layer 1 and Layer 2 services. The acquisition of existing Telstra copper network assets for an agreed price is a fundamental component of the planned migration of Australian DSL and hybrid fibre-coaxial (HFC) broadband consumers to the fibre network. The Australian proposals allow for the possibility of NBNC_o engaging in aggressive (government-subsidised) price-based competition to induce customers of other competing fixed-line networks, such as Optus’ HFC network, to substitute to the new fibre network if this is necessary achieve the desired level of migration in specific locations¹⁰. Similarly, proposed regulatory constraints on the building of competing fibre networks should ensure a monopoly on fixed-line broadband provision for NBNC_o.

Structural components of the Australian proposal and the competitive positioning of the FTTH networks in relation to other infrastructures are depicted in Figure 1.

⁹ Zimmermann (1980).

¹⁰ Australian Government (2010).

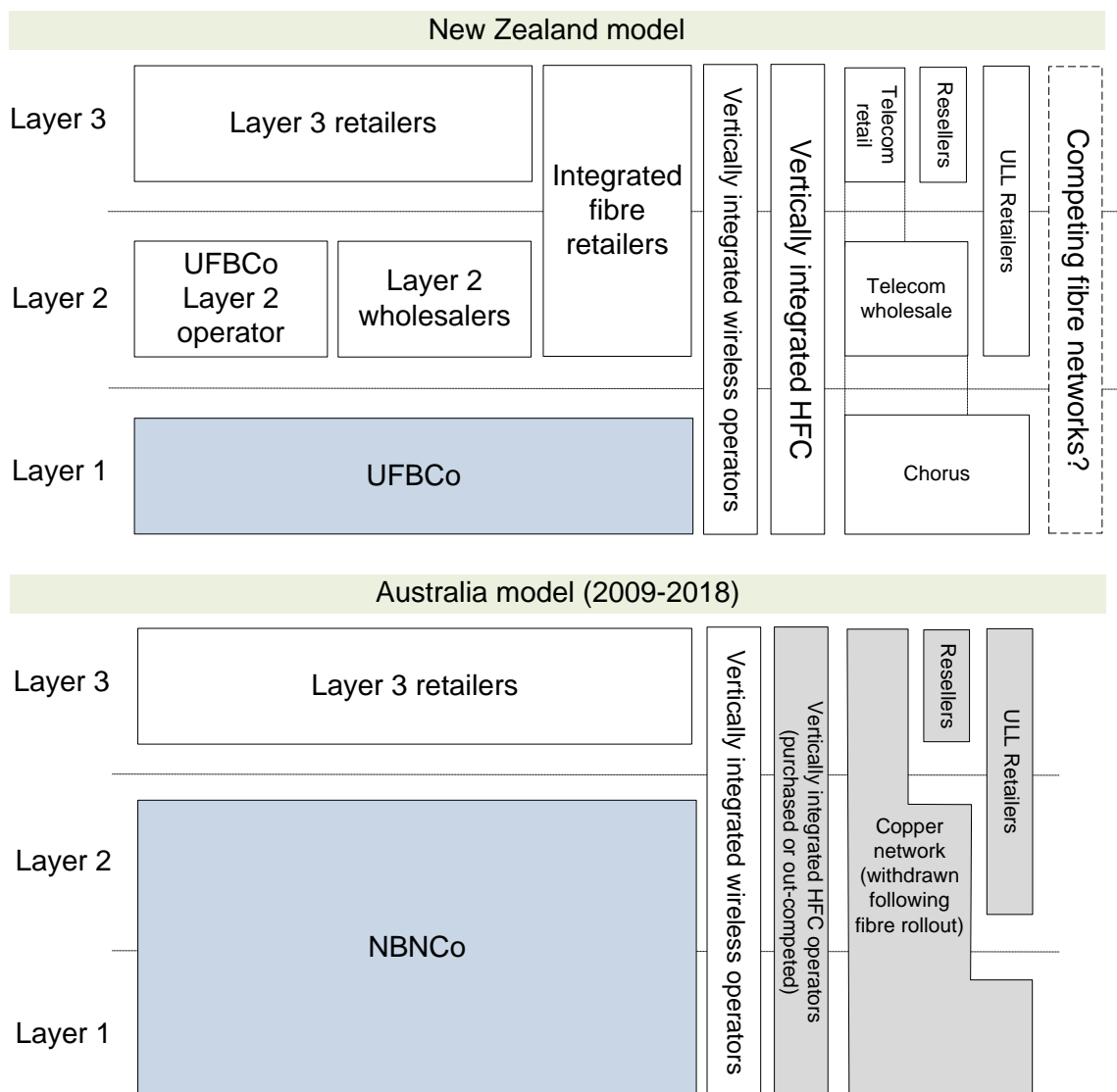


Figure 1. Structural Components and Competitive Positioning of New Zealand and Australian FTTH Proposals

By contrast, the New Zealand proposal assumes that up to 33 regional geographic monopoly public-private partnership firms (UFBCos) will be created to deliver Layer 1 services¹¹. Government funding is attached to the provision of Layer 1 services only. A UFBCo may offer Layer 2 services over their own network; however it must provide Layer 1 services to itself and to all other Layer 2 service providers on equivalent terms¹². Importantly, Layer 3 firms (managing the retail relationships with end consumers) are precluded from having a controlling stake in

¹¹ These firms are described as ‘Local Fibre Companies’ (LFCs) in the Ministry of Economic Development documentation.

¹² <http://www.med.govt.nz/upload/70609/Invitation-to-Participate.pdf>. Appendix 4.

Layer 1 firms. No official position has been taken in the New Zealand plans as to the role Telecom's new fibre-to-the-node (FTTN) network will play in the construction of the new fibre network or the migration of consumers to it from existing DSL connections¹³. The FTTN network, developed as a consequence of binding undertakings entered into by Telecom and the government in 2007, is currently delivering 10Mbps to 78% of the population. VDSL speeds of 40Mbps will be available to 60% of the population by end of 2010, and 80% of lines are expected to be 20Mbps capable by the end of 2011¹⁴.

Despite their apparent 'open access' and non-discrimination' similarities, the differing approaches to separation boundaries and the involvement of the respective incumbent copper-based telecommunications providers will result in two very different environments in which both the price level and price structure of the products offered to retailers and ultimately consumers will be set. There is broad agreement in both countries that ongoing financial viability of the FTTH networks relies upon rapid and early consumer uptake, and that this will to a large extent depend upon extensive migration of existing fixed-line internet consumers (both DSL and HFC) to the new networks.

In Australia, acquisition by NBNCo of Telstra's copper assets means migration of the existing fixed-line broadband customers serviced on the incumbent's copper infrastructure (80% of fixed-line broadband market) can be managed without fear of extensive price-based competition from the dominant fixed-line infrastructure provider (albeit that some competition might be expected from HFC networks and other operators with pre-existing fibre networks¹⁵). By contrast, unless a similar agreement is made within New Zealand, the incumbent operator and its unbundling and wholesale customers (who collectively have 93% market share) will be competing for the same fixed-line broadband customers with the UFBCos and their associated downstream firms.

¹³ It is noted that Telecom submitted a non-conforming response to the request for proposals. On 23 May 2010 the firm announced that it would investigate the feasibility of full structural separation of its copper network from other operations in exchange for the government considering involvement of the firm in the UFB project and revisions of the current copper network regulatory arrangements and undertakings between the firm and the government (for example, the Telecommunications Service Order, which binds the firm to provide universal national copper network coverage at geographically averaged prices and with a mandated flat-rate local voice calling tariff). At the Investor Briefing in Sydney on May 27, the Chief executive clarified that structural separation was only one of a range of possible strategic options the firm was considering.

[http://media.corporate-](http://media.corporate-ir.net/media_files/irol/91/91956/investorday/ChiefExecutiveOfficerTelecomGroupPaulReynoldsStrategyUpdate.pdf)

[ir.net/media_files/irol/91/91956/investorday/ChiefExecutiveOfficerTelecomGroupPaulReynoldsStrategyUpdate.pdf](http://media.corporate-ir.net/media_files/irol/91/91956/investorday/ChiefExecutiveOfficerTelecomGroupPaulReynoldsStrategyUpdate.pdf).

¹⁴ *Communications Day* June 17, 2010, p.1.

¹⁵ Competition from mobile and fixed-wireless broadband can also be expected, however the authors of both Australian and New Zealand proposals have downplayed this threat.

Aggressive price-based competition from copper (and other infrastructure) providers threatens the ability of the UFBCos to obtain sufficient customers quickly enough to generate the returns necessary to induce both the degree of private sector investment expected and the anticipated levels of capital cost recovery that are fundamental to the delivery of the New Zealand UFB policy.

Clearly, the price *levels* of FTTH connections relative to existing infrastructure offerings will play a key role in inducing customer substitution. Less well-articulated, but nonetheless also extremely important, is the role of price *structure*¹⁶. Historically, network industries with a degree of market power (even in the presence of some (oligopolistic) competition, e.g. mobile telephony) have achieved widespread and early uptake by engaging in various forms of price discrimination. Examples include bundling of services with other products¹⁷, two-part tariffs where usage charged above cost subsidises connections sold below cost, and multiple product offerings sold at prices that reflect customers' relative willingness to pay rather than the costs of production in a manner that enables greater total welfare (both consumer and producer) to be delivered than under the counterfactual of a single, cost-based price¹⁸. Key differences exist between the two proposals with regard to the ability to engage in price discrimination in order to advance the objective of rapid substitution.

As Australia's single integrated Layer-1-and- 2 NBNCos will be offering a wide range of products to its wholesale customers, it will be in a position to engage in a limited amount of imperfect, yet still welfare-enhancing price discrimination over a range of product variants (i.e. classic Ramsey-Boiteux prices, albeit with customer valuations proxied by the valuations of Layer 3 retailers) in order to better achieve the multiple goals of wide and early deployment, rapid and widespread uptake, low average costs of production and rapid recovery of fixed costs outlaid whilst similarly maximising welfare from the provision of faster services. By contrast, New Zealand's Layer 1 UFB firms, bound to offering a single dark fibre product at non-discriminatory terms¹⁹, in

¹⁶ Howell (2008).

¹⁷ For example, equipment (such as handset and modem bundling) or complementary services (such as television content).

¹⁸ That is, classic 'Ramsey-Boiteux Prices', where the ratio of the relative markups over marginal cost of two (or more) services is equal to the ratio of the inverse elasticities of demand for the services (Laffont & Tirole, 2002).

¹⁹ UFB firms are required to offer a 'specified' dark-fibre product on these terms. They are permitted to charge a premium for a dedicated fibre over a shared fibre; however this premium must be cost based. NBN data suggests that the relevant cost increment is around 8%, so the price differential will be small. These two products should be suitable for all homes and the great majority of businesses.

competition with an ADSL provider similarly bound to offer non-discriminatory prices, will be unable to garner the full benefits of scale economies available under integration and price discrimination. Rather, they will be required to forfeit any surpluses from price discrimination enabled as a consequence of product variety to the Layer 2 and 3 operators, rather than being able to use them to offset the high fixed costs of Layer 1 network deployment. The New Zealand approach will lead to higher average costs and prices, and very likely handicaps the rapid deployment and development of uptake of the UFBCos' fibre networks, and increases the risks of failing to achieve ongoing financial viability relative to the Australian NBNCo counterpart. However, the limitations of structural separation mean that in neither country can the full range of price discrimination practices, as is observed in countries where the fibre providers face no structural separation mandates, be utilised to accelerate the substitution of existing broadband consumers to the new networks.

This paper explores the implications of the different approaches towards separation and price discrimination in the Australian and New Zealand fibre proposals for the ability to achieve the stated objectives of rapid deployment and uptake, and ongoing financial viability, especially given that they must be obtained substantially in advance of extensive consumer demand developing for the network's high-speed capabilities (relative to already-deployed close substitutes).

Section 1 outlines the key theories of price discrimination, and the ways in which price structure can be utilised to bring forward the time at which both a social planner will find it welfare-enhancing and a business will find it profitable to invest in a new natural monopoly technology where demand for it is still relatively immature. Section 2 provides a brief overview of the competitive environment into which the NBN and UFB are being introduced, and draws upon insights on demand patterns and price structures from other countries where FTTH networks are widely deployed in competition with other infrastructures. This section highlights the challenges of inducing substitution in an environment where there is as yet little evidence of significant consumer willingness to pay substantial price premiums for network speeds appreciably faster than current incumbent offerings, and where technological capacity for enhancing the speed of existing technologies still exists. Given these constraints, and given the long history of price discrimination across different speed offerings, it would appear to be very difficult to achieve substitution and uptake objectives without price discrimination in the sale of FTTH products. Section 3 compares and contrasts the potential for price discrimination to be profitably and

beneficially deployed to enhance the economic potential of each of the Australian and New Zealand FTTH network proposals, given the structural boundaries and competitive restrictions imposed by those proposals. Section 4 concludes.

1 Welfare Effects of Price Discrimination in a Natural Monopoly

Technologies with high fixed costs typically have a downward-sloping average cost of supply as quantity produced increases (economies of scale), as illustrated by the curve (S) in Figure 2. This occurs because marginal costs (MC) are small by comparison, and either constant or decreasing as the quantity produced increases, so the shape of the average cost curve is dominated by the spreading of the fixed costs over an increasing production volume.

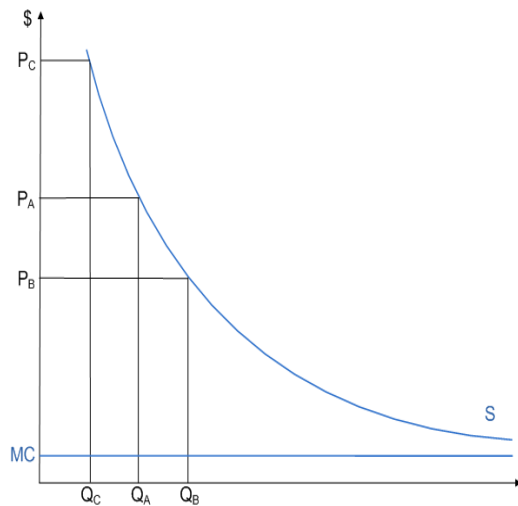


Figure 2. Natural Monopoly Cost Structure

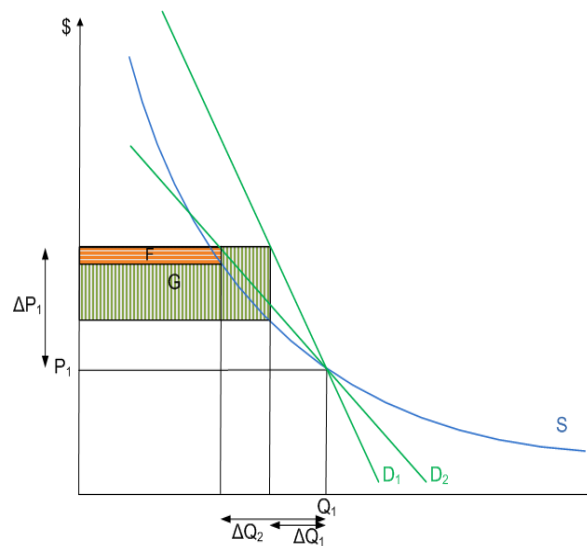


Figure 3. Demand Curves

As long as the total quantity that can be sold in a market lies in the region where the average cost curve is decreasing (i.e. economies of scale exist), it will be most efficient for only one firm to produce all units, leading to the creation of a ‘natural monopoly’. Given the average cost curve S in Figure 2, it costs $\$P_A$ to produce each of Q_A units. However, if more units are produced (i.e. Q_B), it costs only $\$P_B < \P_A to produce each of those Q_B units. A single supplier faced with such a cost structure thus finds it most profitable (i.e. least costly) to make as many units as the market is prepared to buy at a given price. Indeed, it is in the interests of the efficiency of the economy generally if a supplier with such a cost structure is protected from competitive entry by other suppliers with similar cost structures, in order to ensure that the units are produced at this least possible cost. For example, if a competitor with the same cost structure enters the market and

sells $Q_C = (Q_B - Q_A)$ units, then the average cost of production for the total Q_B units will rise. The Q_A units produced by the incumbent rise in cost to $\$P_A$ each, and as $Q_C < Q_A$, the entrant's average cost per unit $\$P_C$ is even higher than $\$P_A$.

The higher are the fixed costs of production relative to the (approximately constant) marginal costs, the more likely it will be that a natural monopoly will arise. As the fixed costs of producing goods such as fibre networks are very large (e.g. acquiring development consents and rights-of-way, building exchange or interchange facilities, digging trenches and laying fibre), and the marginal costs of making another unit are relatively small (connecting up a single household to a connection already laid in the street, delivering information along that connection), they tend to exhibit characteristic natural monopoly cost structures. Technological change has vastly reduced the costs of communication equipment over recent years and hence reduced the likelihood of true natural monopolies occurring in some geographical markets (e.g. densely populated urban environments²⁰). However natural monopoly cost structures (and their attendant monopolistic consequences) may still be relevant where addressable markets are small (i.e. towards the left of the average cost curve, where it is relatively steep and economies of scale are significant).

Suppliers of goods with natural monopoly characteristics thus seek to deploy their infrastructure widely in order to deliver the largest number of units at the lowest possible unit cost. To recover the large fixed costs, it is desirable to sell as many connections as possible as quickly as possible. However, the price that the supplier can charge is determined by the willingness of consumers to pay for the good. When there are few close substitutes for the good, and consumers value the good highly (i.e. their demand is said to be inelastic and the demand curve is steep – D_1 in Figure 3), the supplier can charge a high price (i.e. ΔP_1 above cost $\$P_1$, in order to maximise profits – measured by the sum of shaded areas F and G) without altering the number of units sold very much (ΔQ_1). However, the more substitutes consumers have for the good, or the more they prefer to spend their constrained budgets on other goods, the flatter is the demand curve (i.e. it is said to be more elastic – D_2). The same change in price ΔP_1 alters the quantity sold by a much larger amount (ΔQ_2), and the profit yielded is only area F. Thus, when demand is more elastic, the supplier's ability to set the price in order to maximise profit is more constrained.

²⁰ Where two or more networks technologies can be deployed without reducing efficiency as each is operating in the flat, right-hand side of the average cost curve in Figure 1 where returns to scale are approximately constant.

The total number of units that can be sold, and ultimately the average cost of the units produced and sold at a price that at least covers the costs of production (i.e. suppliers will not incur a loss, and will therefore find it worthwhile producing the good), is determined by the slopes and intersection point of the average cost and demand curves. As long as a price and quantity can be found where the cost of production falls below the marginal consumer willingness to pay (demand) for that quantity, the supplier will find it worthwhile (profitable) to produce the good. However, early in the lifecycle of a technology, when the value of the technology is either unknown or unproven to the majority of potential customers, the total potential market (Q) is quite small. Although the most likely initial customers individually are highly-valuing early adopters (and the demand curve likely quite steep, as a completely new technology has no close substitutes), if the fixed costs are very high it may be that the average cost of production is so high that the demand curve falls below the average cost curve over the relevant quantity range (Figure 4). In this case, the demand and supply curves do not intersect. There is no single price and quantity at which the technology can be sold that enables the producer to recover the costs of deployment. In these circumstances, the good will not be produced as there is no way for the producer to recover production costs. Potential consumer surplus (welfare) available to the small number of high-valuing consumers is forfeited from the economy.

If it is deemed sufficiently valuable for the good to be produced (e.g. it is an ‘essential good’, the benefits of which are so large that it cannot be contemplated from a societal perspective that it not be produced and consumed), then it is possible to induce its supply by subsidising its production (e.g. from taxation). However, subsidies lead to reductions in economic efficiency (welfare) as they require taxes to be levied in the markets for other goods and services in order to fund the transfer to the subsidised market. Nonetheless, it is still possible under some circumstances for the natural monopoly good to be profitably produced (without decreasing welfare elsewhere in the economy by taxing other activities) by engaging in price discrimination²¹.

Assume a quantity Q_2 can be produced at an average cost per unit of $\$P_3$. The downward-sloping demand curve means that (if sufficient identifying information is available) it is possible to subdivide consumers into two (or more) groups according to their different willingness to pay for the technology. A higher price $\$P_1$ can be charged to the Q_1 consumers with willingness to pay above $\$P_1$, rendering them with consumer surplus represented by the area of triangle C. The

²¹ The form of price discrimination discussed here (different prices to different groups of customers) is termed “third-degree price discrimination” (Pigou, 1932; Carlton & Perloff, 2005).

remaining $Q_2 - Q_1$ customers can be charged price $\$P_2$, leaving them with consumer surplus represented by the red-outlined triangle (E plus part of B). The profits made by selling Q_1 units at a price $\$P_1$ above average unit cost $\$P_3$ (rectangular area A) can be used to offset the losses made by selling $Q_2 - Q_1$ at a price $\$P_2$ below average unit cost $\$P_3$ (rectangular area B). As long as the size of the profits exceeds the size of the losses, (area A exceeds area B), the supplier also makes a net profit (producer surplus) so will be sufficiently induced to produce the good without the need for a social planner to intervene by offering taxpayer-funded subsidies. Price discrimination thus leads to higher total welfare being generated (the sum of consumer and producer surpluses $C + E + A - B$) than under either the subsidised counterfactual or where no production of the good occurs. From a distributional perspective, higher-valuing consumers in effect subsidise the consumption of lower-valuing ones²². Moreover, a welfare-maximising social planner will seek to maximise the quantity sold subject to the producer breaking even (i.e. area A is no smaller than area B). This was the classic approach taken to the use of price discrimination in telephony networks when they were government-owned and operated.

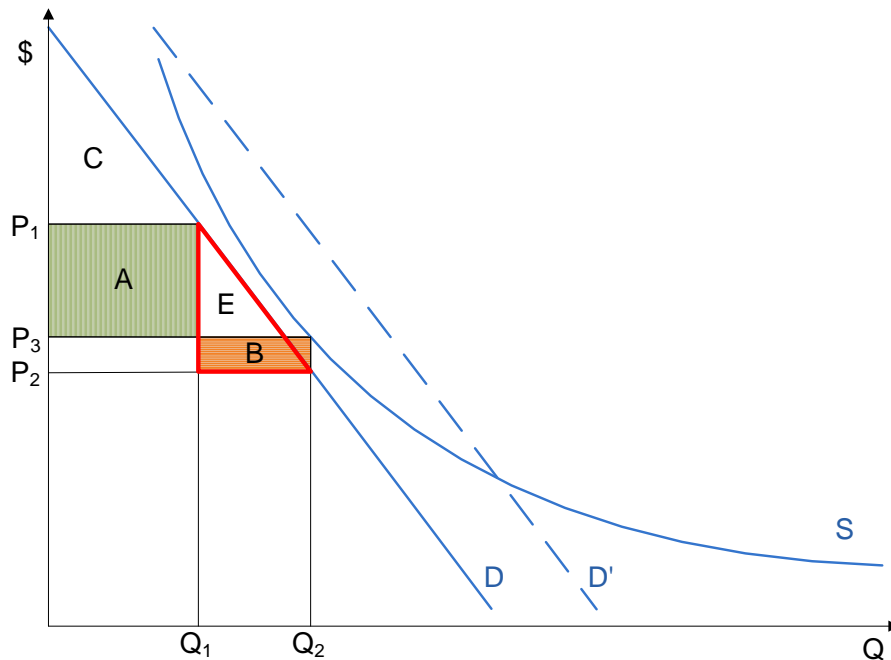


Figure 4. Price Discrimination Allows Introduction of a Technology Not Produced at a Single Price

Price discrimination can also be applied to increase total welfare relative to the case of monopoly pricing, even when the cost curve falls below the demand curve (Figure 5). Assuming the

²² In a manner similar to progressive taxation where higher earners pay more tax lower earners.

monopolist sets price and quantity to maximise profit – that is at the point of maximum vertical distance between the demand and average cost curves where quantity Q_1 produced at average cost C_1 will be sold at price $\$P_1$, generating consumer surplus A and producer surplus B. However, both producer and consumer surplus increase if Q_2 units are produced at average cost $\$P_2$, with the additional $Q_2 - Q_1$ units being sold at the new (lower) average cost. The original Q_1 customers are no worse off, but the producer surplus now increases by the size of the cost savings from making the original Q_1 units at lower average cost $\$P_2$ (area E) whilst the new $Q_2 - Q_1$ customers receive additional consumer welfare represented by area F which would not be achieved under a single (monopoly) price. Both aggregate consumer and producer surplus (and hence total welfare – a Pareto improvement) are therefore enhanced by the practice of such price discrimination²³.

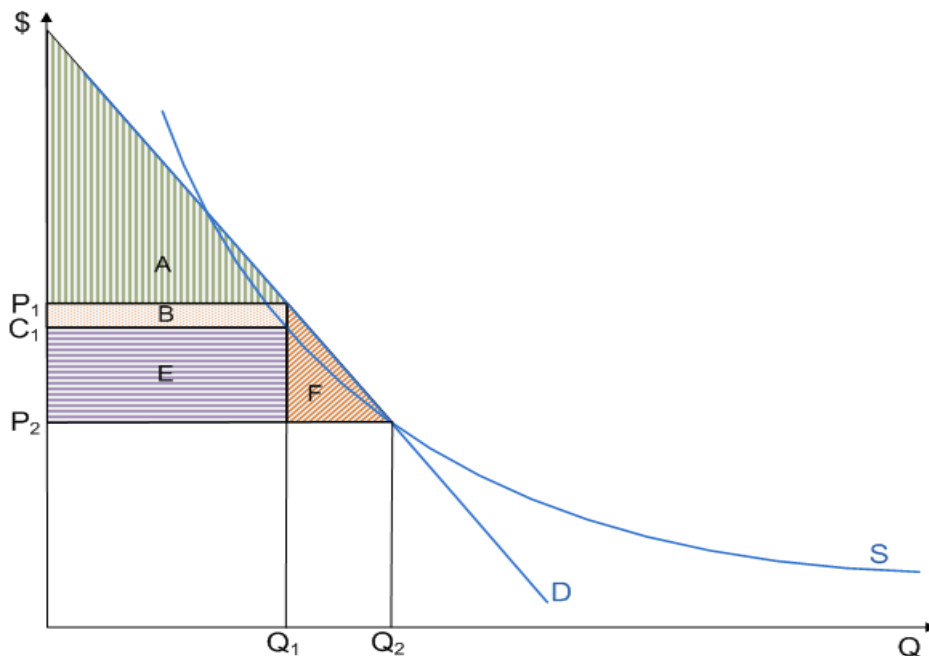


Figure 5. Price Discrimination Increases the Quantity Produced

No explicit policy intervention is required to achieve this outcome: the price structure creates incentives for a profit-maximising infrastructure owner to act in a way consistent with maximisation of social welfare (although some individuals – often those with higher valuations and hence paying higher prices – may object to such pricing strategies, and hence advocate for price equivalence using equity grounds).

²³ Varian (1985).

Price discrimination is quite common in markets for a wide variety of goods with high fixed and low marginal costs, including computer software (e.g. Microsoft Office is sold in Professional and Academic versions), books and movies (early versus standard release), live performances (early purchase versus ‘rush tickets’ sold on the day of performance), and travel (discounts for off-peak services and for specific customer types such as senior citizens). When telephony, railway and electricity networks were in their infancy, price discrimination between (less demand-elastic) business and (more demand-elastic) residential consumers was the norm. Whilst some policy-makers may deem charging different prices to different consumer groups inequitable and therefore undesirable, Figures 4 and 5 illustrate that if the cost structure for the good exhibits natural monopoly characteristics, mandating a single price for the good will result in a higher average cost of production, a smaller number of customers and less welfare in total (‘static’ efficiency is less) compared to the case of price discrimination. Furthermore, under the circumstances of Figure 4, price discrimination also delivers higher levels of ‘dynamic’ efficiency as it brings forward the time at which a new technology is made available to consumers. Under the counterfactual of a single price, production would be delayed until consumer demand grew sufficiently (i.e. the demand curve moves out to a position where it sits above the average cost curve – D’) to enable the producer to recover production costs.

The ability to practice price discrimination ultimately depends upon the extent that the supplier can identify consumer subgroups with different preferences and valuations, and can prevent high-valuing ones from masquerading as low-valuing ones in order to buy at the lower price. If the product can be customised for each group (and thereby rendered less useful for other customer groups) at relatively low cost, many different products costing a similar amount each can be produced and sold to the different customer groups at very different prices according to their varying willingness to pay (‘versioning’). For example, it costs Microsoft very little to set the soft switch to turn off access to advanced software features, thereby enabling professional and academic versions of its software to be sold at very different prices. Likewise, identical network services can be sold under different contractual terms to different customer groups, or software switches set at exchanges or cabinets to customise the speed of service an individual broadband consumer receives.

As long as the prices at which the products are sold differ according to customer willingness to pay rather than the cost of production, then ‘versioning’ similar-cost products is in essence price

discrimination. Ramsey and Boiteux have both separately demonstrated that social welfare is maximised subject to the firm's profit being non-negative (i.e. all costs are met) when the price for each such 'versioned' product is inversely proportional to its demand elasticity²⁴. As the market demand curve is the aggregate of the separate demand curves for each of the product variants, and the higher-valuing consumers are those with the more inelastic demand curves, it is now clear that price discrimination by 'versioning' can be used as part of a strategy to gain access to economies of scale at the same time as bringing forward the time of investing in producing a new product with natural monopoly cost characteristics²⁵.

2. Price Discrimination in FTTH Networks: an International Context

The defining characteristic of the market for internet access services since they first became widely available in the 1990s has been a rapid increase in both the capability and availability of data transmission speeds (both upload and download) available to end users. Whereas in 2000 the average advertised downstream speed of broadband connections in OECD countries was less than 500Kbps²⁶, by 2008 this had increased by a factor of 34 to more than 17Mbps²⁷. Simultaneously, broadband internet connections have become widespread, to the point that the technology is approaching diffusion maturity in many countries²⁸. Yet whilst faster connections have enabled the more widespread use of applications such as audio and high-definition video streaming, peer-to-peer exchanges and sophisticated video gaming, the applications utilised by the vast majority of residential consumers can be quite adequately delivered to most consumers using currently-available and future-projected upgrades to DSL and HFC networks.

Even though a wide variety of broadband speeds is available in many countries, most residential users appear unwilling to pay substantially more for faster connections (i.e. although a few individuals will pay a premium for speed, the demand for fast broadband connections quickly becomes quite elastic as the number of consumers increases), at least in advance of their ability to gain benefits from applications that can only be used with the faster connections²⁹ (Figure 6).

²⁴ Ramsey (1927); Boiteux (1956).

²⁵ Shapiro & Varian (1999).

²⁶ Assessed from speeds surveyed by the OECD, pp 52-3 in OECD (2001).

²⁷ OECD (2009) p 107.

²⁸ The cumulative average growth rate of broadband connections between 2005 and 2007 in early leader Korea was only 1.38% (OECD, 2009, p 128).

²⁹ This point was first made with respect to the payment of a premium for faster broadband when dial-up connections were the norm, but is equally applicable to the availability and purchase of faster broadband connections (Howell, 2003).

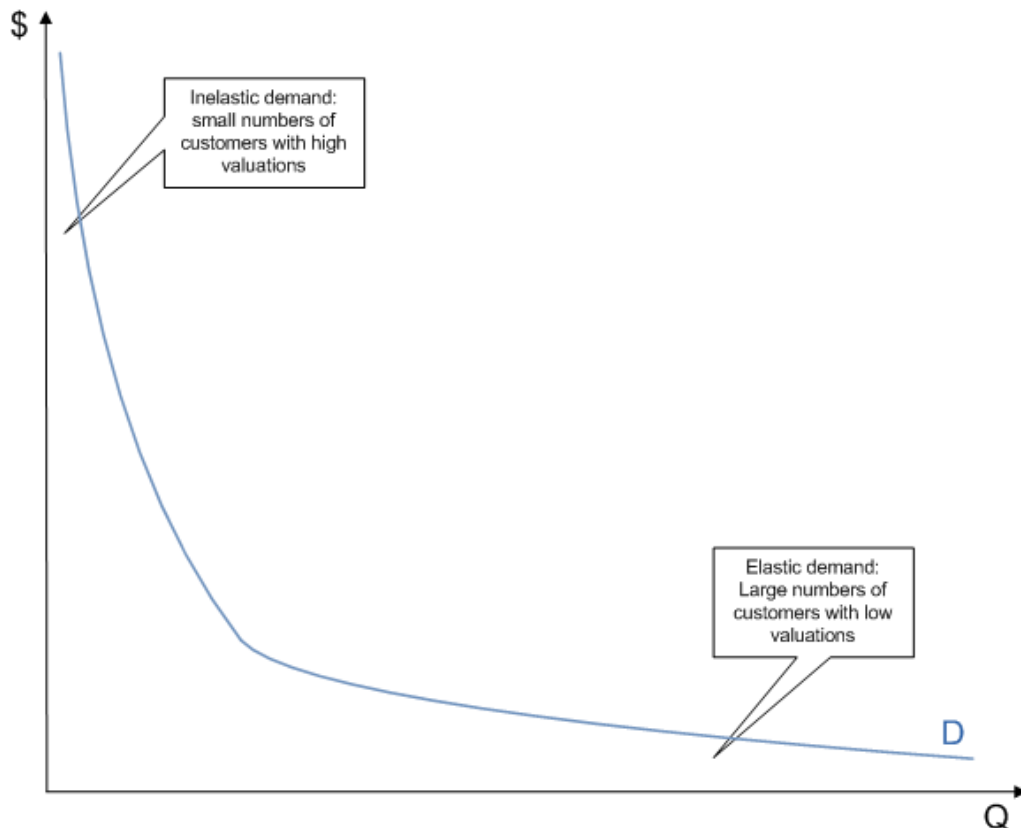


Figure 6. Likely Demand Curve for Fast Broadband Connections

For example, despite having the choice of one of the OECD's broadest ranges of speeds and technology types, only around one third of United States residential broadband consumers have opted to pay a price premium to purchase a broadband connection faster than their provider's standard-offer speed³⁰. Even so, the average price paid for premium-speed connections was only 1.2 times the average price paid for standard-speed connections³¹. As the fastest connections contemporaneously offered by AT&T (ADSL – 10,000Kbps), Time Warner (HFC – 15,000Kbps) and Verizon (FTTH – 50,000Kbps) exceeded the price of the respective firms' standard-speed (768Kbps) offerings by a factor of 3.4, 2.5 and 7 respectively³², it would appear that despite a wide array of speeds on offer, the average premium-speed connections actually purchased in the United States do not substantially exceed the speed of the standard offering.

The apparent lack of willingness to pay substantial premia for faster broadband connections likely derives from the fact that, although there is a range of bandwidth-intensive applications from

³⁰ Horrigan (2010a).

³¹ Horrigan (2009).

³² OECD (2009). p.309.

which some consumers may derive tangible benefits when using faster connections, these applications still remain in large part the domain of specific niche user groups rather than of mainstream users. Historically, it has been observed that a small proportion of users consume a disproportionately large share of network resources (i.e. mean volume of data downloaded is substantially larger than median)³³. This occurs because the applications commonly reported as the most important and frequently used by the majority of broadband users are not bandwidth-intensive, so rarely necessitate the purchase of super-fast connections to render satisfactory experiences for the end-user.

United States evidence from the Pew internet surveys confirms that the demand for applications requiring fast broadband connections is far from substantial. Fewer than 50% of broadband users have ever engaged in bandwidth-intensive activities such as playing games online or downloading or streaming video. Most-valued applications for the ‘average’ user include low-intensity activities such as buying products online, obtaining local national and international news (over 80% of users), online banking (70%) and social networking (55%). Of those consumers purchasing premium-speed broadband connections (one third of broadband purchasers), only 67% had ever watched an online video or viewed online content on video-sharing site (e.g. YouTube or Google Video), and only 23% reported undertaking such activities on a daily basis. Only 20% of the premium-speed purchasers had ever downloaded or shared content on peer-to-peer sites, and fewer than 5% undertook such activities on a daily basis. These percentages for premium-speed subscribers are not substantially different from the statistics for all broadband connection subscribers (60% and 20% for video-watching; 17% and 3% for peer-to-peer exchange)³⁴, consistent with the hypothesis that the plethora of high-speed plans currently offered is most likely a reflection of supply-side preferences rather than a response to application-driven consumer demands for faster services as a consequence of consumers having large appetites for applications that can only be used with a very fast connection.

Furthermore, technological development is rendering competitor technologies ever more capable. VDSL speeds in excess of 100Mbps symmetrical (upstream and downstream) are already feasible using copper, DOCSIS 3.0-enhanced HFC infrastructure is already delivering speeds in excess of 200Mbps symmetrical and early trials of LTE cellular technology are reporting speeds in the vicinity of 100Mbps. As it is likely that enhancing existing networks to achieve these speeds will

³³ See, for example, Howell (2003).

³⁴ Horrigan (2010b); Horrigan (2008).

be less costly than building completely new fibre networks, it is not at all clear that, given current applications, fibre technologies have a natural advantage even with respect to delivering high speeds. Moreover, by their very nature, fixed-line connections restrict consumers to accessing the internet at a specific location. As has been evidenced in the voice telephony market, consumers are willing to pay a positive price premium for mobility, even though the quality of mobile services may be lower than fixed line ones.

Rather, evidence is emerging that many consumers are choosing to spend their (constrained) household communications budgets on a portfolio of connection types rather than a single fixed-line connection. In Quarter 4 2009, the average speed of broadband connections purchased worldwide fell for the first time ever as demand for mobile connections to service an increasing array of personal devices (e.g. iPhones, Kindles, data sticks etc.) grew³⁵ and the pool of non-broadband users decreased in an increasingly mature fixed-line market. As any extra money to purchase more expensive residential fibre connections must come from decreases in spending on other items, and as the growth of household expenditure on communications services has been declining since 2004³⁶, it begs the question of exactly which spending, will be sacrificed in order to fund household fibre first purchase. Such spending will occur only if the benefits from fibre purchase exceed those achieved from consumption of the sacrificed items.

Given that there is little compelling evidence to suggest that pent-up consumer demand for faster broadband connections makes their imminent deployment essential to liberate substantial application-based welfare gains for which consumers are willing to pay, why are suppliers engaging in the deployment of ever-faster connections? One plausible explanation is that, given an investment has already been made in a network (i.e. capacity is available) and a customer has already purchased a connection, it is a relatively low-cost activity to alter the speed of the connection in question. By offering a menu of speeds, each one of which likely costs a similar amount to deliver (versioning) at vastly different prices (price discrimination using Ramsey-Boiteux prices), network operators can induce consumers to self-select into different groups by opting for the version that best meets their requirements, and hence signal their willingness to pay for services with different qualities.

³⁵ Akamai State of the Internet Report Q 4 2009, as reported in *Communications Day* April 22 2010, p 10.

³⁶ OECD (2009, p 35).

That is, faster speeds act as a means of extracting a price premium out of high-valuing (and likely early-adopter) customers, enabling the practise of welfare-enhancing price discrimination. With such information, network operators can set their price structures such that they can bring forward the time at which new networks (e.g. fibre) and/or enhancements (such as FTTN and DOCSIS3.0) can be deployed relative to the counterfactual of a single price for each technology type. As the demand curve for faster broadband connections is likely nonlinear, with only a small number of consumers willing to pay very high prices (inelastic demand) and the vast majority having very little propensity for paying much for speed (elastic demand) (Figure 6) practise of price discrimination is eminently feasible. Slower low-price (and even below cost) connections can be sold to the vast majority of low-valuing consumers, increasing the total number of customers connected and thereby reducing the network operator's average cost per connection, whilst simultaneously extracting profits from high-valuing consumers purchasing faster connections, in order to both bring forward the time of deployment and (if necessary) subsidise the connections sold below cost to obtain necessary scale.

OECD evidence appears to bear out the price discrimination hypothesis. All OECD countries offer broadband connections over a wide range of speeds, both uploading to and downloading from the internet. With the exception of Japan and Korea, where all fibre connections are offered at 100Mbps symmetrical, fibre providers are competing with DSL and HFC technologies principally by replicating the speeds offered by those other technologies, rather than relying upon high speed-based differentiation to attract customers. For example, Table 1 shows asymmetric fibre connections³⁷ are the norm in the United States and the Netherlands, and in Denmark and Finland, fibre products are offered over a range of speeds starting lower than the average speed (17Mbps) offered across all technologies over the OECD.

³⁷ Asymmetric speeds offer another mechanism for price discrimination. The majority of connections are to net data-consumers, and thus can be expected to select an asymmetric plan over a higher-priced symmetric plan. The supplier can use this to extract a price premium from the net data-producers who require at least a symmetric plan (typically businesses).

Table 1: Fibre Offers in OECD Countries, 2008³⁸

Country	Provider	Speeds (Kbps) (download/upload)
Denmark	Danske Bredband	512/512; 2000/2000; 10,000/10,000; 20,000/20000; 25,000/25/000; 50,000/50,000; 100,000/100,000
Finland	Elisa	1000/1000; 2000/2000; 5000/5000; 10,000/10,000; 50,000/50,000; 100,000/10,000; 100,000/100,000
The Netherlands	KPN	30,000/3000; 50,000/5000; 60,000/6000
United States	Verizon	10,000/2000; 20,000/5000; 20,000/20,000; 50,000/20,000

Table 1 also confirms that fibre operators are apparently in large part replicating the low-speed offers of the legacy cable and DSL operators. For example, Danske Bredband’s 512Kbps offering does not utilise any of the fast delivery capacities of a fibre network, so can only be offered in order to compete directly with existing operators for low-speed customers. A strategy of mimicking other technologies is essential if it is substitution of existing low-valuing, low-speed customers from existing networks to fibre (in order to achieve scale economies) rather than consumer demand for faster connections that is both driving the uptake of fibre connections and underpinning the economic case to deploy such networks in the first place.

OECD price data are also consistent with the hypothesis that strategic pricing by fibre operators in the presence of other competing networks is necessary to induce substitution. In all four countries listed in Table 1, fibre connections are priced either at the same level or below equivalent-speed or higher-specified DSL and HFC products³⁹. As fibre connections on new networks undoubtedly cost more per connection than upgrading existing HFC or DSL networks, then undercutting competitors’ prices for slower connections will be economically sustainable (absent subsidies from external sources) only if price discrimination is occurring. That is, price premiums charged to high-valuing high-speed consumers are subsidising below-cost connections sold to low-valuing ones, and in order to remain economically viable in a market where different technologies compete, the premia charged for very fast fibre connections must be proportionately much higher than those charged by competing DSL and cable operators. Again, OECD pricing data appears to confirm this hypothesis. Very fast fibre connections are sold at a substantial premium over the fastest (and most expensive) DSL and HFC connections available (e.g.

³⁸ Source – OECD (2009, pp 302-309).

³⁹ E.g. Verizon’s 10,000/2000 fibre service costs US\$42.99 per month compared to US\$55.00 for AT&T’s 10,000/1500 VDSL product; Danske Bredband’s 10,000/10,000 fibre connection costs US\$(PPP)34.04, compared to \$45.43 for TDC’s 10,000/1000 ADSL product and \$35.18 for Stofa’s 10,240/512 HFC product.

Verizon's 50,000/20,000 fibre connection costs \$USD139.95, some 30% more than Qwest's 20,000/896 ADSL product; Danske Bredband's 100,000/100,000 fibre connection at US\$(PPP)113.85 is nearly twice the price of TDC's 50,000/2000 ADSL product). Notwithstanding such pricing strategies, fibre connections comprised only 11% of Danish and 6% of United States fixed broadband connections in June 2009⁴⁰.

If the hypothesis of strategic use of price discrimination to engender substitution is plausible then the spread of both speeds and prices must be very broad in order to finely segregate consumers. Furthermore, the premium products must be priced substantially above cost in order to ensure that the surpluses extracted from the small number of high-valuing high-speed (price-inelastic) consumers is sufficiently large enough to subsidise the very much larger number of low-speed, low-valuing (price-elastic) consumers⁴¹. Again, OECD pricing data appears to support the hypothesis. The price of the fastest speeds offered by individual United States operators exceeded the price of the operators' respective standard-speed offering by a factor between 2.5 and 7 times. Similar price patterns are also observed in Denmark (premium speed 10 times the price of standard), Finland (2.4 times), France (4.4 times) and the Netherlands (4.4 times).

Moreover, price discrimination in retail broadband offerings is unlikely to be a new phenomenon. Ever since OECD broadband pricing data was first reported in 2001, each country has offered a range of both speeds and prices to consumers, regardless of the technology types deployed. All that has changed over time is that the range of speeds offered has become much broader in all countries and the speed of the base level offering has increased as consumer demand for applications requiring faster connections (at the lower end of the speed spectrum) has increased.

It thus appears that in order to encourage widespread take-up in the presence of competition from other technologies, given the current application range and willingness to pay, FTTH services must gain large customer numbers rapidly in an environment where it is clear that demand for very fast services is very elastic over most of the addressable demand curve. The only way that such a strategy could be financially sustainable would be by engaging in widespread retail price discrimination, using a range of speeds offered as a proxy for separating out individual consumers' willingness to pay, discounting low-speed connections sold to the vast majority of consumers below those offered by competitors and charging very high (discriminatory) prices to the

⁴⁰ OECD Broadband Portal <http://www.oecd.org/dataoecd/21/35/39574709.xls>

⁴¹ It is noted that in countries where download data-volume caps have been applied, competition based upon different speed offerings is less intense, especially in respect of uploading speeds (Howell, 2010a).

remainder – i.e. classic price discrimination. However, such a strategy relies upon either there being a sufficiently large number of high-valuing customers and an absence of competing high-speed offers from existing technology providers to ensure that the FTTH operator acquires a disproportionate share of the high-valuing customer market, or a sufficiently large addressable market that two or more network operators can sell enough connections to each take advantage of scale economies in production despite facing competition (i.e. there is no true ‘natural monopoly because the quantity sold (Q) is sufficiently large enough that all operators are selling a quantity on the relatively flat portion of their average cost curves).

3. *Structural Separation: the Australian and New Zealand Contexts*

The observations in the preceding two sections suggest that providers of Australia’s and New Zealand’s fast FTTH networks face some very stiff challenges in encouraging existing broadband consumers to substitute from their existing technologies. FTTH connections require larger capital investment than the already largely-depreciated copper and HFC networks so will necessarily have a higher average cost per connection than their competitive counterparts. Unless compelling new applications are developed that require capabilities only available on fibre networks, and for which consumers are prepared to pay a positive price premium, then widespread substitution to FTTH services will likely be very difficult to achieve unless the fibre operators can engage in extensive price discrimination and compete aggressively with other network operators and their retailers. As both NBNCo and the UFBCos will be competing with existing network providers with the capability of replicating many of the features of fibre, their retailers must offer a range of speeds replicating HFC and DSL offerings, and an even wider range of price levels and price structures (i.e. more finely graduated speed-based price discrimination than already evidenced) in order to induce the necessary levels of substitution to achieve low average costs rapidly and ultimately obtain financial self-sustainability.

3.1 *Structural Separation Precludes Welfare-Enhancing Price Discrimination*

Yet the structural separation requirements that are fundamental to the Australian and New Zealand fibre broadband policies materially affect the ability to garner the positive benefits of price discrimination. Successful price discrimination relies upon detailed knowledge of individual customer valuations of the technology, the ability to segment customers into groups and the prevention of high-valuing consumers masquerading as low value ones and product resale. But structural separation precludes any positive benefits from price discrimination garnered at Layer 3

where retail relationships with end consumers are mediated being passed through to the Layer 1 and 2 operators in order to offset their very high proportion of fixed costs. It thus impedes the ability for network operators to utilise price structures to either access economies of scale in production or enable early introduction of a technology exhibiting natural monopoly cost characteristics. In short, it militates against the alignment of incentives facing industry participants that would otherwise lead them to adopt strategies consistent with increasing total welfare generated from the sector.

Table 2. Open Systems Interconnection Model

Layer	Description	Products offered	Proportion of cost ⁴²
1	Physical layer	Dark fibre ⁴³	70%
2	Data link layer	Bitstream connection between customer premises and local or regional points of interconnect	20-25%
3	Retail layer	Cross-network communication; white label consumer data plans	5-10%

As Table 2 illustrates, the bulk of the fixed costs of the Australian (and most likely also the New Zealand) FTTH deployment – and hence the area where the proceeds of retail price discrimination must be applied in order to minimise average costs – are incurred at Layer 1. To a lesser extent, there are also some fixed costs at Layer 2. But at Layer 3, where the greatest ability to practice welfare-enhancing retail price discrimination lies (see Table 3), fixed costs – and hence the incentive to utilise such pricing structures for either maximising fibre connection uptake rates or minimising average costs – are negligible.

⁴² See Exhibit 9-2 in: Australian Government (2010).

⁴³ ‘Dark’ or ‘unlit’ fibre means a physical fibre connecting two points. It has no practical use without Layer-2 equipment at both ends of the fibre which ‘lights’ the fibre and allows the transfer of data.

Table 3. Basis for price discrimination

Layer	Possible bases for price discrimination
1	None – same dark fibre product to everyone ⁴⁴
2	<ul style="list-style-type: none"> • Maximum speeds (upload and download) • Data volume cap (upload and download) • Minimum guaranteed speeds (upload and download) • Changes to these limits based on time of day
3	Same bases available at Layer 2 plus: <ul style="list-style-type: none"> • Customer identity • Bundling with other goods, services and content • Differential rates based on the source or destination of data flows

Structural separation has been applied in legacy copper telephony (and electricity) networks principally as an instrument to militate against the existing market power of an operator with an established, mature network. Specifically, separation precludes Layer 1 and Layer 2 operators from having direct engagement with retail customers in order to prevent both price and non-price discrimination that may harm competitive entry in downstream Layer 3 markets⁴⁵. By constraining the exertion of market power by requiring Layer 1 and 2 operators to supply standard products at equivalent terms and prices to all Layer 3 operators, welfare (both static and dynamic) otherwise lost from reduced competition at Layer 3 is recovered⁴⁶. This will result in a net gain in welfare so long as any gains from increased competition at Layer 3 are greater than any attendant welfare losses at Layers 1 and 2.

There is only one circumstance where structural separation of a natural monopoly provider is likely to lead unequivocally to welfare gains at Layer 3 without invoking substantial losses at Layers 1 and 2 from reduced access to scale economies: where the network is already widely deployed, scale economies have already largely been achieved and there is evidence that the integrated operator has been using price and non-price discrimination specifically with the intention of foreclosing competitive entry⁴⁷. Presuming the network operator has been engaging in welfare-enhancing price discrimination (as per Figure 5), the available economies of scale will likely have already been captured. As discussed in Section 1, if feasible, an integrated operator

⁴⁴ While in theory a Layer-1 operator could price discriminate using contractual constraints on the use of each dark fibre connection, it could not enforce or monitor compliance without installing its own Layer 2 equipment. At this point it is duplicating the infrastructure (and costs) of the Layer-2 operator.

⁴⁵ Xavier & Ypsilanti (2004); Howell, Meade & O'Connor (2010).

⁴⁶ Economides & White (1995); Cave (2006).

⁴⁷ Whinston (1991).

will maximise both profits and total welfare by engaging in such a strategy. The quantity produced will already be set at the maximum level Q_2 , where the demand curve intersects with the average cost curve. However, an integrated operator faces reduced incentives to engage in the development of new Layer 3 products and services offered over the network. Competition induced from access regulation and structural separation increases the range of Layer 3 products and services available (dynamic efficiency gain). Arguably, such competition also reduces any Layer 3 productive (static) inefficiencies within the formerly monopoly provider.

Whilst a greater range of products and services undoubtedly increases consumer welfare, if the technology is already widely deployed, the potential to sell more connections (and hence increase access to scale economies at Layers 1 and 2) is not large, as the average cost curve beyond Q_2 connections becomes relatively flat. Furthermore, productive efficiency gains at Layer 3 are most likely to emanate from changes in the already small marginal costs. Whilst the average cost curve may shift down very slightly, its slope will not alter greatly as a consequence of such gains. Consequently, altering industry structure by imposing access regulation or structurally separating out the Layer 1 and 2 operators in a mature network will very likely induce welfare gains at Layer 3 without substantially interfering with the underlying industry cost structure⁴⁸. Aside from any dynamic welfare gains from Layer 3 product variety, the most significant discernable effect of structural separation is likely the wealth transfer from the (formerly) monopoly producer to high-valuing consumers, who now pay the (single, equalised) market price for their connection. Whilst consumer welfare increases as a consequence of the price change, there is no change in total static efficiency as a consequence of this reallocation alone.

At any other stage of a network technology's life-cycle, however, structural separation⁴⁹ imposes a necessary welfare trade-off between the benefits of increased Layer 3 competition and the losses invoked from restricting the ability of Layer 1 and 2 operators to use pricing strategically to access scale economies. Whilst Layer 3 operators can engage in price discrimination, without direct responsibility for the recovery of the high levels of fixed costs over other parts of the network (they purchase their network inputs from lower-layer operators at per-unit prices) they face no cost-based incentives to do so. Any price discrimination practices undertaken by separated Layer 3 operators are therefore most likely motivated solely by individual profit maximisation rather than overall network cost minimisation or welfare maximisation.

⁴⁸ Only if the productive efficiency gains are very large or the demand curve quite steep at the margin will there be a discernable effect upon the average cost of the number of connections sold.

⁴⁹ And arguably also access regulation (Howell, Meade & O'Connor, 2010).

Consequently, under structural separation fewer connections will be sold, the average cost of production will be higher and total (static) welfare lower (regardless of whether the network is operated by a profit-maximising private owner or a welfare-maximising social planner) than under an integrated counterfactual. Moreover, dynamic welfare losses are also incurred if the separation-induced prohibition on price discrimination delays the time at which investment in the new network occurs. At worst, if the demand curve sits above the average cost curve, the network will not be deployed, even though it could be provided under a price discrimination scenario.

The extent of static welfare losses arising from separation-induced prohibitions on price discrimination will be greatest when the average cost curve is declining most steeply (i.e. in the early stages of deployment, when the number of connections likely to be purchased (Q) is smallest), and when the demand curve across the addressable market is more inelastic (i.e. as usually occurs during the early stages of deployment of a new technology). These are precisely the circumstances prevailing at the introduction of a new technology, where the dynamic welfare consequences are also greatest. Such analysis suggests that the most costly time to impose structural separation and its attendant non-discrimination obligations upon a natural monopoly network technology (i.e. when the losses at Layers 1 and 2 are likely to be greatest, and the gains at Layer 3 least) is when the network is initially deployed.

Such reasoning brings into question the policy rationale for the imposition of structural separation on the Australian and New Zealand FTTH networks. As structural separation is more likely to lead to higher welfare in a mature, widely deployed technology, then to impose it as a structure upon a new network where there are likely significant short-term costs suggests that, if long-term welfare maximisation underlies the policy, then a judgement has been made that the welfare gained in the future from competitive neutrality at Layer 3 (Australia) and Layer 2 (New Zealand) will be either much larger or more highly-valued than the more immediate benefits of lower net costs at the underlying layers and wider early deployment of the technology.

The policy documentation for both the Australian and New Zealand proposals provides no clear statements of how the trade-off between gains from Layer 3 competition versus losses at Layers 1 and 2 was assessed in either coming to the decision to impose separation or in determining between which layers the separations would apply. At best, in the following statement, the New Zealand policy makers indicate that their imposition of a separate structure likely derives from optimal regulation of a mature, widely deployed technology (the current “best practice” derived

from regulatory intervention in copper-based networks where an existing operator has demonstrated market power) rather than from a reasoned analysis of the most efficient structures for an embryonic new network⁵⁰:

“...the government is putting in place up-front design arrangements for the [Local Fibre Companies] that are intended to give ex-ante effect to many of the regulatory treatments that are current best practice in the telecommunications sector. These include restrictions on retailing, retail ownership, requirements to provide specified open access products, and equivalence and transparency obligations.”

Whether by accident or design, the effect has been to prioritise the benefits arising ultimately from competition at Layer 3 over scale economies at other layers of the network. Arguably, this approach is consistent with an approach in New Zealand in recent years that has favoured regulatory and policy choices that increase retail competition over those that might have resulted in greater net increases in welfare, but compromise the pursuit of increased retail competition⁵¹. By jumping straight to an industry structure that is better suited to the end-stage of a technology’s lifecycle (and that is in fact the structural equivalent of the functional separation mandates imposed upon the incumbent copper network provider in 2007 – see Figure 1), policy-makers appear to have excluded the possibility of an evolving industry structure that could both enable access to scale economies at an early stage and countervail against the risks of competitive foreclosure at a later stage.

By contrast, Australian policy makers have taken a more nuanced position. Despite requiring separation of Layer 3 operations, the NBN proposal enables network operator control of product differentiation and access to limited price discrimination during the rollout phase (2009-2018) via integration of Layer 1 and 2 services. After 2023, it is envisaged that the Australian industry will transition to structural separation above Layer 1⁵² (at which point it will be similar to the New Zealand model). Whilst consistent with the arguments outlined in this paper – that the ability to price discriminate (to some degree) is essential during the rollout phase and a transition to imposed structural separation is possible (and perhaps desirable) once the network is mature – it is impossible to tell if this policy has been arrived at as the outcome of a reasoned analysis from weighing the relative static and dynamic efficiency considerations or a consequence of (as seems to be the case in the New Zealand case with respect to an existing investment in functional and

⁵⁰ <http://www.med.govt.nz/upload/69988/Ultra-fast-Broadband-Initiative-Overview.pdf>. p 16

⁵¹ Howell (2010b).

⁵² Australian Government (2010). Exhibit 10-7. p 480.

structural separation) other path-dependent artefacts of the Australian telecommunications policy development processes.

3.2 Implications of Strategic Interaction under Separation and Competition

A key assumption underpinning the rationale for pursuing structural separation is that the network concerned is truly a natural monopoly – that there is a ‘bottleneck’ infrastructure that is all of essential, unavoidable and uneconomic to replicate⁵³. If, however, any of these assumptions does not hold true, then a separated network may not be just more costly per connection and less efficient than a vertically integrated counterfactual, but also at a significant competitive disadvantage vis-à-vis vertically integrated partial and complete substitutes.

Whilst it may be possible for a government to mandate a separate structure for a particular infrastructure, with its attendant consequences of a higher average cost of supplying connections, the ability for the network operator to recover those costs from consumers will be determined by consumer willingness to pay and the range of alternatives available. If there are no close substitute networks, the demand curve is relatively inelastic, and it falls below the average cost curve over the relevant range of connection numbers, then it is possible for the natural monopoly operator(s) at Layers 1 and 2 to set a single price for relevant services prices to Layer 3 operators so as they can recover their costs (i.e. without having to rely on ongoing subsidies). The Layer 3 operators will be able to pass on the higher costs to end consumers without fear of being undercut by fully vertically integrated operators or competitors with access to alternative Layer 1 and 2 infrastructures.

However, in a competitive infrastructure environment, where partial substitutes exist, separated Layer 3 operators will struggle to sell their (higher-cost) connections to end consumers unless the (Layer 1 and 2) technologies they are delivering contains a compelling quality advantage that will induce consumers to pay the significantly higher price premium that separation imposes on their network (Layer 3 differentiation alone is insufficient, as these services can be supplied over any network infrastructure, including the competing ones). If structurally separate Layer 1 and 2 operators are precluded from engaging in price discrimination, they are unable to co-ordinate with Layer 3 operators to replicate either their competitors’ cost structures or their retail price structures. Vertically-integrated competitors aware of the limitations faced by the separated operators can now compete even more aggressively (for example, an even wider array of products

⁵³ De Bijl (2005).

and services sold at discriminatory prices) in order to maximise their own market share and benefits from scale economies. Such aggressive competition will not necessarily be confined to the retail market – for example, as they face no obligations to provide services on equivalent terms, competing network operators may use the benefits of scale economies they enjoy in order to induce the separated operators’ Layer 3 retailers to switch their customers to the alternative infrastructure. The closer the comparability of the features of the two networks (i.e. the more customers view them as perfect, rather than partial, substitutes) the more likely it will be that the separated operator(s) will struggle to gain market share and recover costs.

Under these competitive circumstances, it may be extremely difficult for the owners of a separate network to obtain even a small number of customers, further inhibiting the ability to access scale economies and potentially undermining the very financial viability of the network itself. Combined with the discussion in the previous subsection, this suggests that imposing structural separation on a nascent network, at least in the absence of other mechanisms to restrict competition, is not just likely problematic in respect of maximising welfare, but also imposes substantial limitations that hamstringing the ability of the separated operators to compete on equivalent terms with other networks. The new network may fail to get sufficient new customers to cover its fixed and sunk costs, putting pressure on its ongoing financial viability.

3.3 The Australian and New Zealand FTTH Proposals

The competitive reality is that both the Australian and New Zealand FTTH networks will be implemented in an environment where there is already widespread deployment and uptake of DSL and HFC broadband services. There is no reason to presume that consumer demand for fast services in Australia and New Zealand will be very different from that exhibited in the United States Pew surveys and other OECD countries⁵⁴, so the rapid deployment of the FTTH networks will be achieved only by inducing existing broadband consumers with very limited willingness to pay substantial premia for speed to substitute to the new networks. The structural separation requirements create substantial competitive and cost structure impediments to achieving the desired rapid widespread deployment and early uptake. Instead, the rates of uptake will likely be substantially lower than under the OECD comparators of Section 2, where there is evidence of significant levels of aggressive price discrimination occurring on the nascent fibre networks in order to induce customers to switch. Even if the FTTH networks did not face infrastructure

⁵⁴ Indeed Castalia Strategic Advisors (2008) reported a low willingness to pay for faster broadband in New Zealand.

competition, the separation mandates will mean that the number of connections would be less and the average cost per connection higher than under an integrated counterfactual where price discrimination was possible.

As the underlying financial case for cost recovery of the Australian and New Zealand networks is so precarious, it is hardly surprising that networks of the specified technology will be built only with the assistance of government subsidies. However, the structural separation mandate in particular imposes a set of costs and impediments that will result in that subsidy having to be both very much larger, and applied over a much longer period of time, than if a more flexible view was taken of the optimal institutional structure of and the pricing options available to the firms providing FTTH services. Nonetheless, it is apposite at this point to examine each of the Australian and New Zealand proposals separately, in order to form a view of the extent to which the unique characteristics of each may affect both the relative and absolute sizes of government support that will be necessary to create and maintain the networks envisaged.

3.3.1 The New Zealand Proposal

The New Zealand proposal requires the UFBCos to sell dark fibre (Layer 1) services at a single non-discriminatory price to all access seekers. Access seekers could be Layer 2 wholesalers, integrated Layer 2/3 providers or even end users. It is not clear whether there will be a single nationwide price for dark fibre, or one that varies by region.

Layer 2 wholesalers will determine the variety of different speeds of internet access that will ultimately be sold to end consumers by Layer 3 providers. The single price for Layer 1 services, which comprise around 70% of the fixed costs of the network, must be set by the Layer 1 operator(s) (or regulator) ex ante, without knowledge of the range of speeds that the Layer 2 operators will make available, or access to the information regarding how consumers at the Layer 3 level value access to the network. A ‘guess’ must be made about how many connections will be sold in order to determine the single price. If actual demand is less than that estimated, the Layer 1 operator will be unable to recover costs (of course, errors in the other direction are likely to result in a reduction in the regulated price for services to be made available). As Layer 2 operators do not bear the costs of Layer 1 investment, they have a strong incentive to ‘overestimate’ the number of connections they will sell in order to encourage the Layer 1 operator (or regulator) to believe scale economies can be achieved, and therefore to set the single price lower. This leads to systematic errors in price setting in separated natural monopoly networks

that are avoided when the risks of demand estimation errors can be internalised (eliminated) via integration⁵⁵.

Layer 2 wholesalers control the choice of speed offerings made available (i.e. the degree of product differentiation offered on the network to enable segmentation of retail customers) and will set (or a regulator may set) the prices charged to non-integrated Layer 3 retailers. Whilst Layer 2 wholesalers face some fixed costs of their own, and therefore face an incentive to structure their (Ramsey-Boiteux) prices accordingly in order to maximise scale economies as they relate to their own production costs, they have neither the ability nor the incentive to structure their prices in order to maximise the scale economies available to the Layer 1 operator. Furthermore, as they have no direct interaction with retail customers, they are limited in their ability to discern end customers' willingness to pay for various service speeds and qualities and hence to structure either their speed-differentiated offerings or prices optimally. Instead, they must rely upon on either at best the information provided by or willingness to pay of their Layer 3 customers as a proxy for retail consumer valuations in order to set imperfect Ramsey-Boiteux prices, or at worst must accept regulated, cost-based prices that will effectively eliminate their ability to garner any benefits of price discrimination for either themselves or the Layer 1 operator. In either case, their ability to use pricing to optimise network welfare is considerably constrained.

Ultimately, it is the Layer 3 operators who hold the key to setting prices and recovering the costs of deployment at all layers of the network. Fully separate Layer 3 operators have neither the ability to pass through any proceeds of retail price discrimination to Layer 1 or 2 operators nor the incentives to set their prices so as to maximise network efficiency. However, as they manage the customer relationship, they have all of the information and ability to engage in price discrimination for profit-maximising purposes. As for Layer 2 operators, they have no incentives to truthfully share their information about likely end consumer demand patterns to their upstream suppliers if doing so will result in reductions in their profits (for example, by leading to a higher price for services). This likewise exposes separate Layer 2 operators to risks in respect of setting their costs and quantities. If there are no restrictions on vertical integration between Layer 2 and 3 operators, there are strong incentives for Layer 2 operators to vertically integrate downstream into Layer 3 operations in order to internalise the risk. Integrated Layer 2/3 operators thus have substantial cost/risk advantages over separate operators, as well as the advantage of being able to use price discrimination to recover the share of fixed costs incurred at Layer 2, suggesting that

⁵⁵ Howell, Meade & O'Connor (2010).

unless there are further forcible separations, the New Zealand market will likely converge to a small number of integrated Layer 2/3 operators competing under a Cournot-style oligopoly model rather than a large number of separate operators at each layer competing under Bertrand-style competition.

Separate Layer 3 operators are therefore likely to emerge only with regulatory support (e.g. forcible separation or price regulations requiring integrated operators to make Layer 2 products available at equivalent terms to competitors and integrated operations, as per access regulation), or if there are other compelling commercial advantages that enable them to be profitable despite having to pay higher prices due to the higher risks imposed by separation. As consumer willingness to pay is based upon the bundle of network capabilities and application features, separated Layer 3 operators have the means to engage in price discrimination (for example, judicious bundling of specific applications and network speeds) for the purposes of individual profit maximisation. A likely consequence is adverse selection, where specific Layer 3 operators can use targeted applications to ‘cherry pick’ high-valuing (and likely high-speed purchasing) consumers from low-valuing ones, and extract both the network speed and application premia from them, rather than using the proceeds to low-valuing (and likely low-speed purchasing) demand-inelastic consumers⁵⁶, who will end up purchasing services in disproportionate numbers and at overall higher prices from providers unable to extract a price premium because the demand curve of these consumers is essentially flat. Initially, ‘cherry-picked’ price premia will likely be extracted as free profits by separate Layer 3 operators. However, in the manner of classic monopolistic competition, in the long run the presence of profits will encourage both higher levels of Layer 3 (retail) entry and more aggressive development of applications designed to ever more finely separate consumers by their willingness to pay than is optimal⁵⁷. The costs for all Layer 3 operators will rise, to the point where, at the industry level there will be no net profits (the sunk costs of failed market entry and development of applications not highly-valued by consumers will balance gains made by successful layer 3 operators).

To date, there has been no explicit articulation of the role that the incumbent DSL network operator Chorus, its Telecom Wholesale arm and its retail and unbundling partners (including Telecom Retail) will play in the New Zealand FTTH environment. Over 93% of existing fixed-

⁵⁶ It is noted that structural separation ‘undoes’ the benefit offered by a network as a two-sided platform to maximize welfare. For a discussion on two-sided platforms as a means of capturing and distributing scale economies, see Howell (2006).

⁵⁷ Carlton & Perloff (2005).

line broadband connections sold in New Zealand are provided over Chorus infrastructure. Cable operator TelstraClear (7% market share) has already announced that it will be competing for broadband customers with UFBCos and their Layer 2 and 3 operators in those geographic markets where its HFC infrastructure is deployed. If Chorus and its affiliates were to compete aggressively with the UFBCos and their affiliates, then it will be extremely difficult for the FTTH network to gain either large numbers of customers or access to scale economies.

Without the ability to use price discrimination strategically to induce network substitution by undercutting the cable and DSL operators, the FTTH networks will attract only a very small number of very high-valuing customers. Rather than commercial uptake of fibre services enabling the government to recover the capital costs of network construction at an early date, it may be that the UFBCos can remain in the market only as long as the government continues to provide construction capital. On the other hand, if Chorus becomes part of the FTTH network, and there is only limited competition from alternative fixed-line networks (e.g. in locations where TelstraClear has a presence), then the FTTH network(s) will have an element of market power, so may be able to set prices in order to recover costs. However, consumers will necessarily be paying more for fixed-line broadband connections and there will be fewer of them under this scenario than under a competitive counterfactual, albeit that the government is able to recover taxpayer investments at an earlier date.

3.3.2 The Australian Proposal

Two key differences distinguish the Australian FTTH proposal from the New Zealand one.

First, rather than imposing separation at Layer 1 as in New Zealand, the Australian proposal contains a single, integrated Layer 1 and 2 operator – NBNCos – which will sell a range of differentiated services to Layer 3 operators. Whilst the separated NBNCos faces the same information disadvantages in setting (optimal) Ramsey prices for the array of services offered to Layer 3 operators as the Layer 2 New Zealand firms, the very fact of integration means that, to the extent that it is possible, discriminatory prices can be set. NBNCos is therefore able to use its price structure to carry out transfers from high-valuing, high-speed consumers to low-valuing, low-speed ones in order to gain access to at least some of the scale economies implicit in a cost structure that encompasses 90% to 95% of the network's fixed costs. The Australian arrangements thus offer a very much greater likelihood of accessing available efficiencies, and

hence (absent competitive pressures) of achieving lower average costs and higher uptake levels than are possible under the New Zealand arrangements.

Second, the Australian proposal explicitly eliminates fixed-line broadband market competition for NBNCo and its affiliates. The acquisition of existing copper network operator Telstra is a fundamental component of the Australian plans. Telstra and its affiliates currently have 80% market share in the fixed-line broadband market. Furthermore, the Australian proposals specifically allow for NBNCo to engage in strategic price discrimination in those markets currently served by competing operators if it is deemed that the elimination of infrastructure competition is necessary for the network operator to access cost-reducing scale economies. Access to government subsidies will effectively provide NBNCo with the ability to forgo profits that its private sector counterparts will find very difficult to counter. The effective elimination of infrastructure competition thus grants NBNCo a government-sponsored monopoly position in fixed-line broadband access reminiscent of the legislated government-owned monopoly enjoyed by fixed-line telephony companies prior to the liberalisation and privatisation that began in the 1980s.

Whilst there will necessarily be some compromise in the ability of the Australian network to take full advantage of integration and retail price discrimination as available under vertical integration, it appears much more likely that the ensuing Australian industry structure will be financially self-sustaining much earlier, and will require substantially less in the way of government subsidies per activated connection than the separated structure proposed for New Zealand.

4. Conclusion

The Australian and New Zealand governments have both decided that substantial government intervention is required to accelerate the deployment of FTTH networks, but have chosen very different structural and competitive policies under which the government-subsidised networks will be deployed.

The Australian proposal, by allowing integration of Layer 1 and 2 operations, enables the use of a price structure that will enable some access to the economies of scale that attend an infrastructure with high fixed and very low marginal costs. Whilst the price discrimination that can be undertaken cannot be optimal, due to the separation-imposed barriers to sharing information and discriminatory full revenues across the Layer 2/Layer 3 boundary, there is at least some scope for transfers to be made from high-valuing, high-speed customers to offset subsidised prices to the

larger number of low-valuing low-speed customers in order to increase customer numbers and lower average production costs. The proposal also acknowledges the difficulties of a frontier technology competing for customers against strong competitors with existing (legacy) infrastructures, in that it takes concrete steps to protect NBNC Co from significant infrastructure competition at least during the rollout phase. This will assist NBNC Co to manage the substitution of customers from the old to the new technologies in such a way that the risks of failing to achieve critical customer numbers are minimised

In contrast the New Zealand proposal imposes at the outset a FTTH institutional structure that prioritises pursuit of efficiencies arising from competition and product variety at Layer 3 (retail) over pursuit of scale efficiencies in the provision of an infrastructure (Layers 1 and 2) with very substantial fixed cost components. Layer 1 infrastructure providers lack both the ability to engage in price discrimination to access scale economies and protection from competing providers offering close substitute products on other infrastructures. This will lead to the dual disadvantages of a higher cost structure than their competitors and the demand side risks of being unable to take a managed approach to the migration of customers from legacy to frontier technologies, as is available to NBNC Co in Australia. The New Zealand structures are therefore likely to be both more costly and exposed to greater risk of failure than their Australian counterpart.

This is not to say that the Australian proposal would be ideal for either country. Whilst competition from fixed line networks may be managed, NBNC Co will still face competition from cellular and fixed-wireless broadband suppliers with ever more capable networks. These competitors will continue to have full control over their structure (i.e. vertical integration or separation as economics, not policy determines) and price structure (i.e. unrestricted price discrimination based on actual customer demand rather than demand proxied by intermediaries). Australian Layer 3 FTTH retailers will still be able to appropriate some of the proceeds of retail price discrimination rather than applying them to accelerate the diffusion of FTTH connections.

While there are problems with both proposals, it would seem that the policy objectives are more likely to be met sooner and at lower costs in Australia than in New Zealand.

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